The First Iron Works in Canada

Fathi Habashi
Department of Mining, Metallurgical, and Materials Engineering
Laval University, Quebec City, Canada
Fathi.Habashi@arul.ulaval.ca

***Abstract*- The first blast furnace in Canada operated in Trois-Rivières in Quebec during the French Regime in 1735 using charcoal as a reducing agent. It was shut down in 1883 because it could not compete with iron produced using the new technology of coke as a reducing agent. The site has been investigated and developed by Parks Canada and maintained as a Canadian Industrial Heritage Landmark.**

Keywords- Iron production, Charcoal furnace, Forges du Saint Maurice, New France, Canadian Industrial Heritage Landmark

I. INTRODUCTION

The period in the history of Canada known as New France lasted for about 200 years and it was marked by wars, revolutions and associated along with intellectual and social changes. Following Jacques Cartier's (Figure 1) first voyages of exploration, it was Samuel de Champlain (Figure 2) whom founded the city of Québec in 1608 and established the first French permanent settlement on this continent which gradually extended to the Gulf of Mexico to become known as New France (Figure 3). New France empire ended in 1760 when the British defeated the French Montreal and Quebec and took control of the colony. Shortly afterwards, the British had their own revolution in the North American colonies in 1775 while the French lived through the end of the Old Regime in 1789.

Fig. 1Jacques Cartier (1491-1557) discoverer of Quebec

Fig. 2 Samuel de Champlain (1567-1635) founder of the French colony in Quebec City

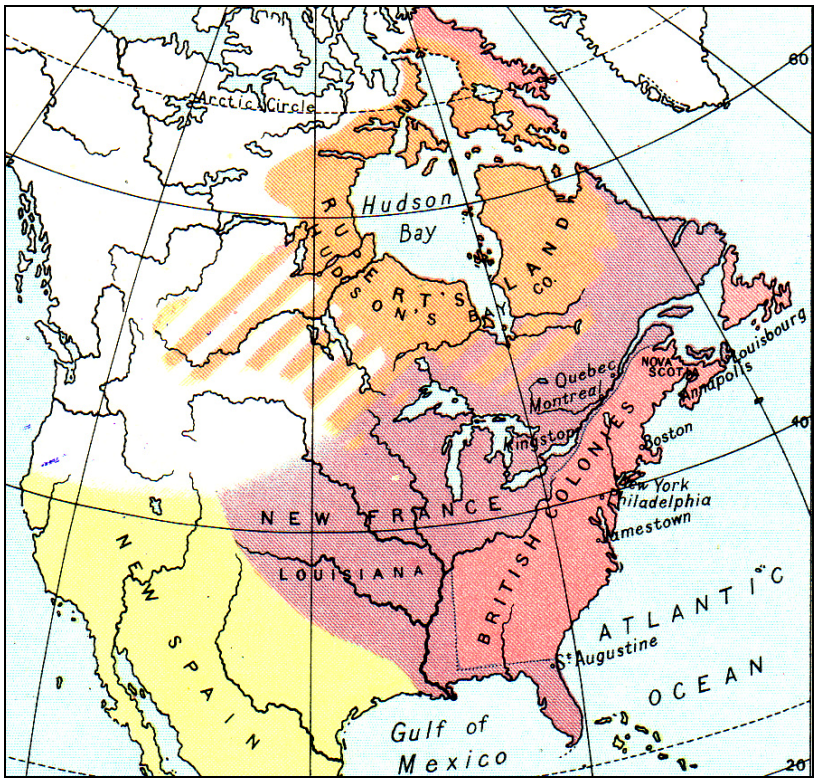

Fig. 3 New France (Source Internet)

The Province of Québec is considered to be the birthplace of chemical education and metallurgy in Canada. Two institutions contributed mainly to this reputation: Le Collège de Jésuites founded in 1635 and La Société des Missions Étrangères, known as Le Séminaire de Québec founded in 1668. Le Collège was closed permanently in 1776 and its library which contained old and valuable books was in part bequeathed to the library of "Le Séminaire" as well as to other institutions. Meanwhile, Le Séminaire flourished under its founder François de Montmorency-Laval, first Bishop of New France during the reign of King Louis XIV. That XVIIth Century institution was transformed in 1852 by Queen Victoria into a university named Laval University to honour its founder.

Among the earliest chemical industries introduced to New France were brewing, lime production, pine-tar distillation used in boat building, and leather tannery. As early as the 1680's, we have mentions of potash production used as an export to France to meet the needs of the soap and glass industries. Wood ash was collected from domestic stoves and fireplaces, and from lime kilns, then agitated with water, filtered to remove the unburned portions of the wood, then the solution evaporated to dryness in iron pots and heated to red heat to burn off as much as possible of the organic content.

II. THE FIRST METALLURGICAL INDUSTRY

The only metallurgical operation in New France and the first in Canada was the Forges du Saint-Maurice located on the bank of Saint Maurice River near Trois-Rivières, half way between Québec City and Montréal (Figure 4). Saint-Maurice River is one of the largest tributaries of Saint-Lawrence River.

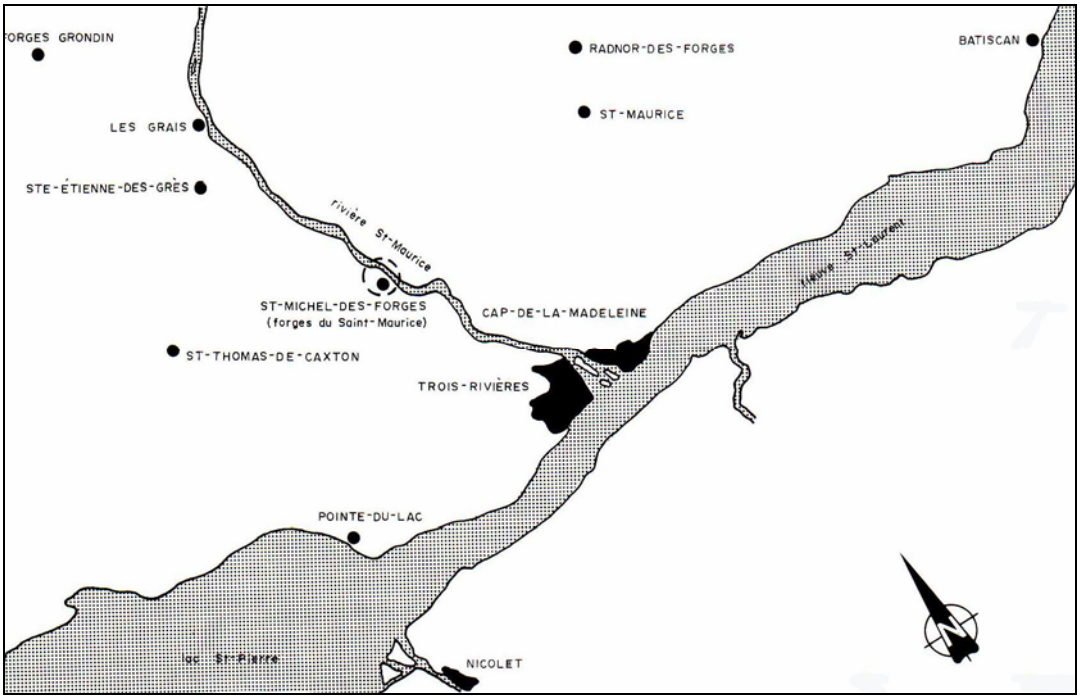

Fig. 4 Location map of the Forges Saint Maurice

The story of the Forges dates back to 1667 when iron ore was discovered in the neighbourhood of Trois Rivières. It was investigated by an engineer named Monsieur de la Pontardière at the request of the Indendant Jean Talon. Although he reported favourably, nothing was done because at that time the colony was under control of the "West India Company" which was mostly involved with in the fur trade. In 1675 the charter of the West India Company was surrendered and in 1730 the French Canadian army doctor Michel Sarrazin examined the deposits.

The first attempt of iron production at the Forges du Saint Maurice was in 1733 by François Poulin de Francheville (1692-1733), a rich French merchant from Montreal whom had sent three smiths to New England to collect information on how to build a furnace to transform iron ore. Because of the limited funds available, Poulin de Francheville was forced to build a short furnace fuelled by charcoal into which air was blown by small bellows. The combustion temperature was insufficient to melt the ore properly. Thus, a low quality spongious wrought iron by-product containing a large amount of slag was obtained. The resulting bloom was removed from the furnace, then, hammered while still hot to force out the slag and obtain a nearly carbon-free iron. This wrought iron was ductile and could be shaped into various tools. By and large, the iron bars produced were of low quality, however, we find them as trade items to far away places such as the Jesuit sugar plantation in French Guiana. The operation was suddenly suspended when the owner of the Forges died at the end of the first year of operation. Poulin de Francheville's widow launched the operation anew in 1735 y hiring Pierre-François Olivier de Vézin, an iron master from France whom was brought to Saint Maurice to operate the Forges.

A. Successful Iron Production

When the new company was functional in 1736, more funds were made available by the French monarch as a subsidy and a modern process was used to produce iron. A taller furnace was constructed and larger bellows were used

so that the temperature in the furnace was high enough to bring the molten ore to optimal temperature. The furnace was 9.1 m high and the internal diameter at the hearth was 0.76 m and at the boshes 2.1 m and at the throat 1 m. The air blast was supplied by two tuyeres. A brook flowing through the site was used to move a water wheel which actioned the bellows for blasting air into the furnace. The charge consisted of 270 kg ore, 20 kg limestone, 16 French bushels charcoal (the French bushel weighed 1 kg more than the English). Approximately 3 tonnes of ore and 1 tonne of charcoal were required to make one tonne of iron.

The iron ore in the Trois Rivières region was a sedimentary deposit known as "bog ore", a hydrated iron oxide or more exactly an oxyhydroxide FeOOH (a limonite). It was a yellow porous material that analyzed about 70% Fe_2O_3, 4% SiO_2, 2% Al_2O_3, 1.8% P_2O_5, and 20% loss on ignition. Due to the high temperature, carbon dissolved in the iron and a product known as cast iron was obtained. This product could be easily cast but was brittle. A sample of the iron produced was analysed later by Thomas Sterry Hunt (1826-1892), a former professor of chemistry and geology at Laval University and twice president of the American Chemical Society (1879 and 1888), showed about 0.03%, 0.5% P_2O_5, 0.9% SiO_2, 1.2% Mn, and about 3% total C. To obtain a malleable product, the cast iron must be melted again in an air stream in a small furnace called "finery" to oxidize its carbon content. Most of the product, however, was used as cast iron for making stoves. Daily production averaged 4 tonnes.

In 1741, the company went bankrupt and as the King of France was the only financial backer, the Forges became the property of the crown. Despite the bankruptcy, the company continued to produce. War with England was a constant threat and so, for the next twenty years, production was concentrated on military equipment such as cannons and cannon balls.

In 1743, the Forges passed to the Royal domain and were carried on for several years in the name of the King Louis XV. Besides other extensive repairs, a Walloon hearth was built, and over 180 men were employed at that time, the number increased to 300 in 1815. The Forges played an important role in supplying military material such as cannons and cannon balls for the King's army, as well as for manufacturing large kettles for the potash industry, kettles for evaporating the maple tree syrup, stoves, and in later years railway car wheels.

At the conquest of New France in 1760, the Forges passed with other Royal properties to the British Government and were operated under military authorities. In 1767, it passed into the hands of a private company until in 1845, owing to the dissatisfaction of settlers in the neighbourhood, the Forges was sold at public auction. In 1883, operations ceased since other furnaces had been erected in 1860 at Radnor, not far from the St. Maurice Forge, where ore and fuel could be more easily obtained and the new technology of reduction with coke was used. As a matter of historical interest, the Forges cast shot and shell for the Americans during their siege of Québec in 1775.

B. The Forges as a National Monument

The Forges operated for about a century and half. In 1973 the Government of Québec transferred administration of the site to the Federal Government so that it could be developed as a national historic park for Canada's first metallurgical operation (Figure 5). Immediately thereafter, archaeologists excavated the deserted region. The artefacts they unearthed were cleaned and prepared for use in interpreting the history of the Forges. A blast furnace model (complete with water wheel and air bellows operated by a water current) has been constructed to explain to visitors how iron was produced two hundred years ago (Figure 6).

Fig. 5 A view of the Forges and the Saint Maurice River (the lower furnace)

Fig. 6 A water wheel demonstrating the generation of energy necessary for operating the bellows to introduce air into the blast furnace

The Forges du Saint Maurice are now a remarkable tourist attraction. The park Forges Saint-Maurice is an intriguing spot for visits by laymen and professionals alike. It was recognized by ASM International in 1978 as a Historical Landmark and by the Canadian Institute of Mining, Metallurgy, and Petroleum in 1996 as a Canadian Industrial Heritage Landmark (Figure 7).

Fig. 7 In 1996 the Canadian Institute of Mining, Metallurgy, and Petroleum recognized the Forges as a Canadian Industrial Heritage Landmark. From left: Roch Samson from Parks Canada and author of a book on the history of the Forges, Marie Lavoie of Parks Canada, Carmen LePage of Parks Canada, René Dufour CIM President, and Fathi Habashi Chairman of the Historical Metallurgy Committee of the Metallurgical Society

On the occasion of its 250th the Royal Mint in Ottawa issued a silver dollar in summer 1988 (Figure 8) and Post Canada issued a commemorative stamp (Figure 9). In 1998 a comprehensive fully illustrated volume was published by Laval University Press. Today, a modern blast furnace produces 10 000 tons/day iron. If we compare this with the blast furnace of New France we see how metallurgy made progress in the past years.

Fig. 8 A commemorative dollar 1988

Fig. 9 A stamp issued on the occasion of 250th anniversary of the Forges

REFERENCES

[1] Chouinard, . "Archéologie et archéométallurgie de la forge et des forgerons de l'habitation Loyola en Guyane". 2001-112 pages, Cahiers d'archéologie du CELAT, Université Laval..

[2] F. Habashi, "Chemistry and Metallurgy in New France", *Chemistry in Canada* 27(5), 25-27(1975)

[3] F. Habashi, editor, *A History of Metallurgy*, Métallurgie Extractive Québec, Québec City, Canada 1994. Distributed by Laval University Bookstore, www.zone.ul.ca

[4] F. Habashi, *Readings in Historical Metallurgy*, Volume 1. Changing Technology in Extractive Metallurgy, Métallurgie Extractive Québec, Québec City, Canada 2006. Distributed by Laval University Bookstore, www.zone.ul.ca

[5] M. Moussette, "Le Chauffage Domestique au Canada: Des Origines a l'Industrialisation". 1983, 332 pages, Presses de l'Université Laval, Quebec City, Canada

[6] R. Samson, The Foges du Saint-Maurice. Beginnings of the Iron and Steel Industry in Canada 1730-1883, Les Presses de l'Université Laval, 500 pages, Quebec City, Canada 1998.

[7] That book is also available in French.

[8] J.W. Swank, *History of the Manufacture of Iron in All Ages*, The American Iron and Steel Association, Philadelphia, USA 1892. Reprinted by Cambridge University Press, Cambridge, England 2011.

[9] C.J. Warrington and B.T.Newbold, *Chemical Canada. Past and Present*, Chemical Institute of Canada, Ottawa, Canada 1970.